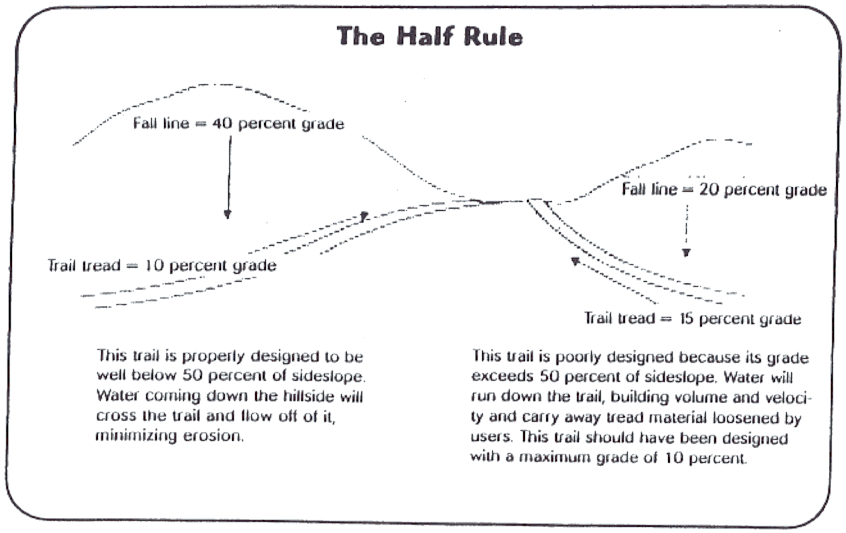
APPENDIX K: TRAIL DESIGN FEATURES

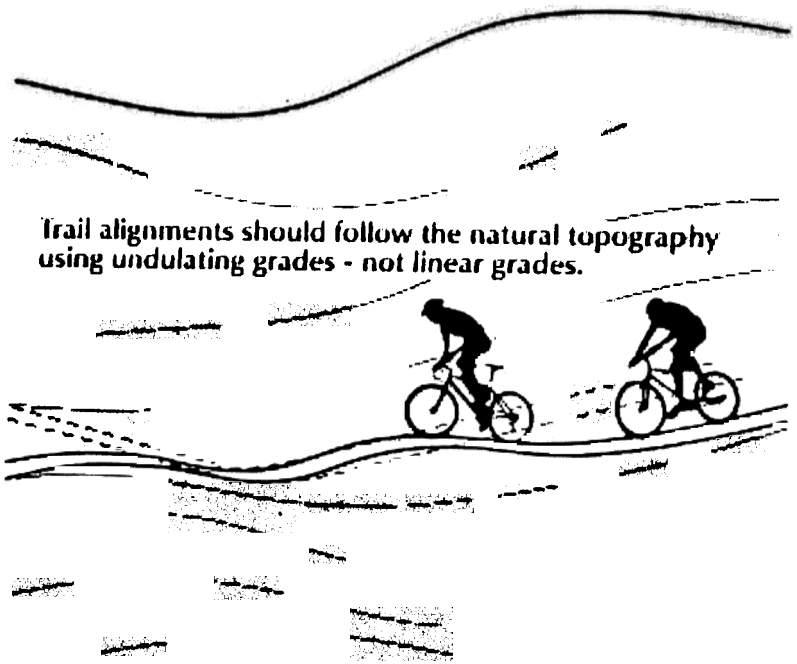


Grade Reversals

A well-built trail has gentle trail grades, an outsloped trail tread and **grade reversals**. As the trail snakes across a hillside, a subtle left or right turn creates rolls or undulations – grade reversals that help divert water off the trail. A contour trail on a steep slope may need grade reversals every 20 to 50 feet, depending on soil type and rainfall. The steeper the grade, the more grade reversals you should have.

To reduce the need to build water-diversion structures later, the original design should encourage smooth water runoff through subtle grade changes. Without proper maintenance, any trail will eventually lose outslope. Grade reversals act as a backup to prevent water from focusing. For more details, see Appendix A.

GRADE REVERSAL



Grade reversals direct water off trail surface and are self cleaning

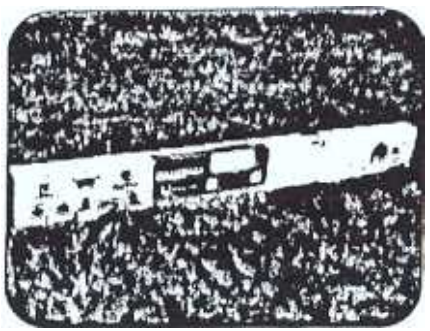
Grade reversals are effective before a water crossing, because they divert water and sediment off the trail before they can reach the stream.

Joey Klein of the TCC works with a clinometer.

Determining the Steepness or Grade of Trails.

A **clinometer** measures a grade in degrees or percent. For highways, roads and trails, percent is used because it's more precise. **Percent of grade** is the relationship between vertical gain and horizontal distance, known as "rise over run." It's found by dividing rise by run. For example, a 100-foot section of trail that gains 10 feet of elevation has a 10 percent rise (10 divided by 100 equals 0.10). Therefore, the trail has a 10 percent grade.

Clinometer.



Digital Level

The Half Rule

A trail **tread** grade shouldn't exceed half the grade of the hillside or **sideslope** that the trail is traversing. If the grade does exceed half the sideslope, it's considered a fall-line trail. Water will flow down the trail rather than sheet across it. Measure the sideslope, then keep the trail tread grade under half of that figure to ensure good drainage.

For example, if you're building across a hillside with a sideslope of 20 percent, the trail tread grade should not exceed 10 percent.

There is a limit to this **half rule**: A trail cannot be indefinitely steep. There can be short, steep sections, but try to limit the maximum tread grade to 15 percent. Of course, this depends on a number of factors, including soil integrity, rainfall, trail flow and number of users. Consider the surroundings to decide what works best.

Trail grades can be steeper on solid rock. But earthen sections between rock may need to be fortified or armored to prevent soil loosening and erosion.

The 10 Percent Rule

Generally, an overall trail grade of 10 percent or less is sustainable. However, there may be steep places where this grade can't be achieved. Trail tread grades can be as high as 15 percent as long as the trail's overall grade doesn't exceed 10 percent.

Begin flagging the route with conservative grades under 8 percent. This allows flexibility in case there's an inappropriate control point. By staying under the maximum grade, you can adjust the route without starting at the beginning.

Outslope in Contour Trail Design

As the trail contours across a hillside, the tread should tilt slightly away from the high side. This tilt, called **outslope**, ensures that water will sheet across the trail. Outslope is a major reason why contour trails work. For more information, see Chapter 4.

Natural Obstacles

Rocks may roll onto a trail and trees may fall across it. In most cases, these things should be removed. But sometimes natural obstacles are a blessing, giving a trail an interesting, technical character. If the majority of people can pass over or through an obstacle while staying on trail, and it isn't trapping water, consider leaving it. Obstacles help keep speed down while giving experienced trail users the challenge they like. For details, see Appendix A.

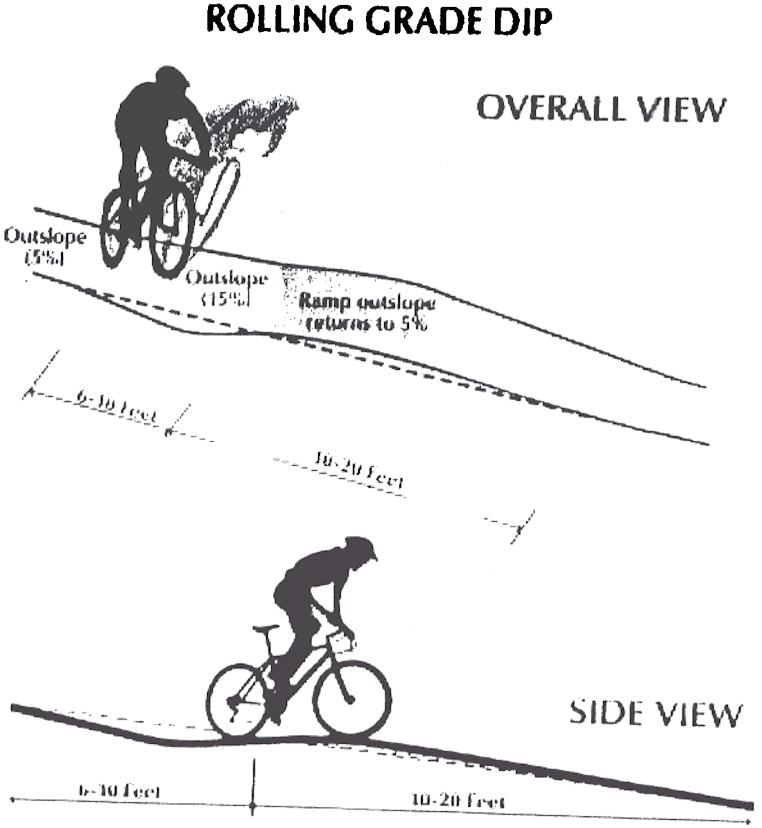
Drainage

As just mentioned, outslope restoration and de-berming are essential to maintaining sheet flow across a trail. However, many contour trails (even those with proper outslope) can benefit from improved drainage. If a trail doesn't have natural grade breaks or reversals to direct water, artificial ones can be added. We recommend two types: rolling grade dips and knicks.

Rolling Grade Dips

A rolling grade dip (RGD) is an unobtrusive way to divert water off the side of a trail by altering the grade. Water is pulled from the trail, not forced off abruptly. RGDs are longer and subtler than traditional water bars. They also are more effective than water bars because they're large and durable, yet smooth enough to be negotiated by all users. They're a particularly good drainage device for trails used by mountain bikers. Unlike water bars, they don't entice cyclists to ride off-trail to get around them. And cyclists won't impact the tread by braking hard as they approach.

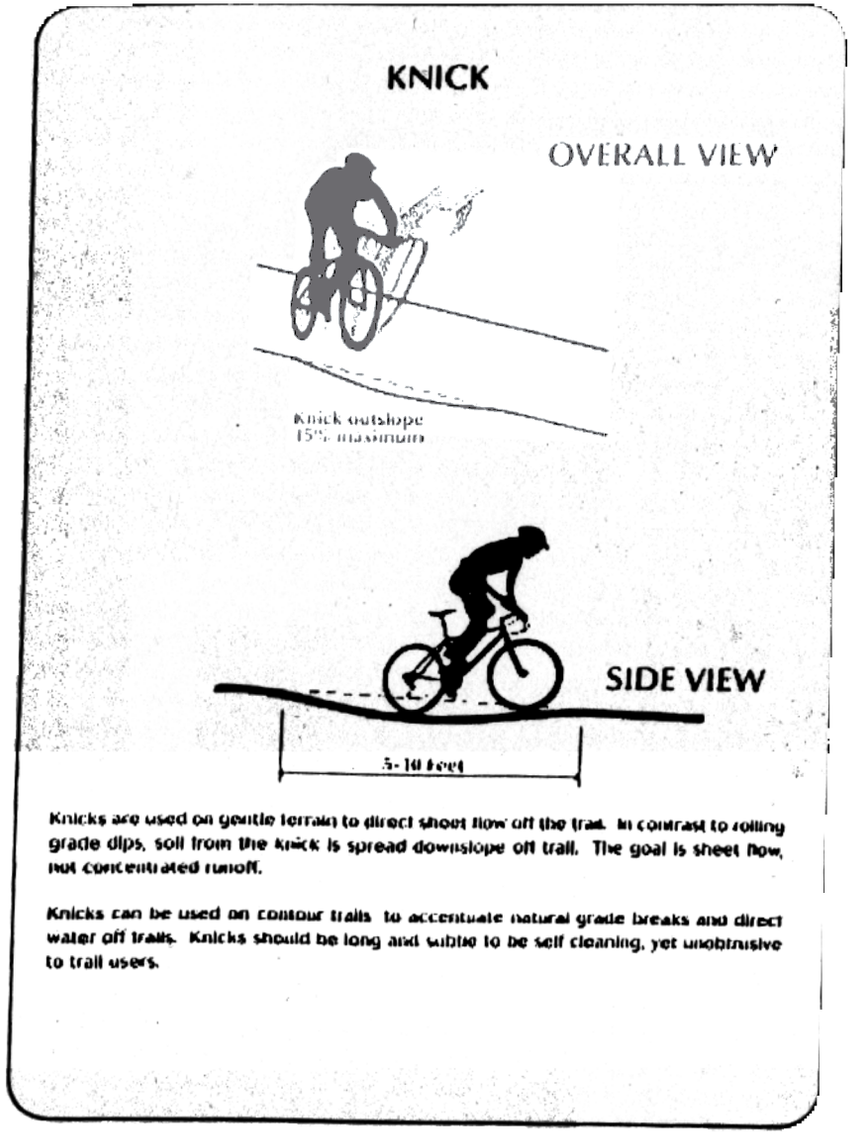
Please visit the trailbuilding section at www.imba.com for more details and photos explaining RGD construction.



Rolling grade dips are a sustainable alternative to water bars. Dips are large enough to be self-cleaning and subtle enough that cyclists won't steer around them. A dip is longer than a bike and shaped like a knick. Use bondable soil from a dip to make a long, gentle ramp just past it. The ramp should be nearly twice as long as the dip.

Knicks

Like a RGD, a knick is smooth and subtle. This is a shaved-down section of trail, about 10 feet in diameter, canted with the hill's natural slope. Knicks are typically built on flatter sections of trail where water tends to puddle. They work well on non-cohesive soils.



Knicks are used on gentle terrain to direct sheet flow off the trail. In contrast to rolling grade dips, soil from the knick is spread downslope off trail. The goal is sheet flow, not concentrated runoff.

Knicks can be used on contour trails to accentuate natural grade breaks and direct water off trails. Knicks should be long and subtle to be self cleaning, yet unobtrusive to trail users.

Re-Routes

Too many trails have been hastily designed. Perhaps they were easy to build, but now they're impossible to maintain. Has a certain trail become a maintenance nightmare? Stand back and look at the big picture. We often find that various problems along a section can be solved with one contouring re-route.

Perhaps a trail is almost always muddy because it goes through the lowest point in an area. It might have fall-line sections, steep grades, poor flow or vulnerability to floods. Look for a new route that solves as many problems as possible. Get permission and do the proper studies. Plant removal or passage through a particular habitat may be issues when proposing a re-route, but in the long run closing a bad piece of trail is better for the environment.

Of course, a trail that's viewed by one person as a steep, eroded, maintenance nightmare might be someone else's favorite challenge. When re-routing around steep sections, look for special features that make the new route challenging while keeping grades sustainable. See Appendix A.

Think about trail flow. Does the new passage fit the flow of sections it connects? Make the re-route more appealing than the old trail with a mix of suitable grades, interesting features and sustainability. The new trail must make users forget the old one. Make it more fun!

Trail Retirement

After constructing an appealing re-route, you need to close the old trail This means restoring its natural state.

Six Key Points for Retiring a Trail:

1. If the old trail was steep, check dams may be needed to hold sediment.
2. The old tread should be scarified, tilled or in some way loosened so that seeds can grow.
3. Cover the old trail with duff, topsoil, plants, grasses and small trees from the new construction.
4. Hide the visual corridor. Low-lying obstacles are not enough. Only when the old trail is out of sight will users abandon it.
5. Education is important. Signs explaining the re-routing benefit help keep people off the old trail.